Transport Times and Lab Efficiency

Providence St. Peter Hospital Echo Lab

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The Echo Lab at St. Peter Hospital has long been plagued by extended wait times for routine and urgent echocardiograms alike. The wait time for an inpatient echo is most often two days and stretches up to four days frequently, most often when following procedure-intensive and low-staff days. The delay in echocardiograms leads to delays in care as well as discharges. Despite this problem persisting for years, little progress has been made in efforts to reduce wait times. The purpose of this report is to identify potential factors that may be helpful in increasing echo lab throughput, as well as to quantify the effectiveness of existing practices.

Analysis

There are multiple sources of variation in the time to perform an echocardiogram. A sonographer must select a patient from the pending list, contact the nurse to arrange transportation, transportation must bring the patient to the echo lab, the exam must be performed, transportation is arranged to take the patient back to their room, and the preliminary report must be written. Different sonographers choose to approach each step slightly differently, and as such the average times for each stage are quite variable. The average times for each stage (regardless of sonographer) are below:

	Mean (SD) Time in Minutes
Transport To Echo Lab	**36.5 (28.1)**
Scan Time	**31.1 (15.1)**
Transport From Echo Lab	**21.9 (16.2)**
Reporting and Finding New Patient	**40.2 (26.3)**

Table 1

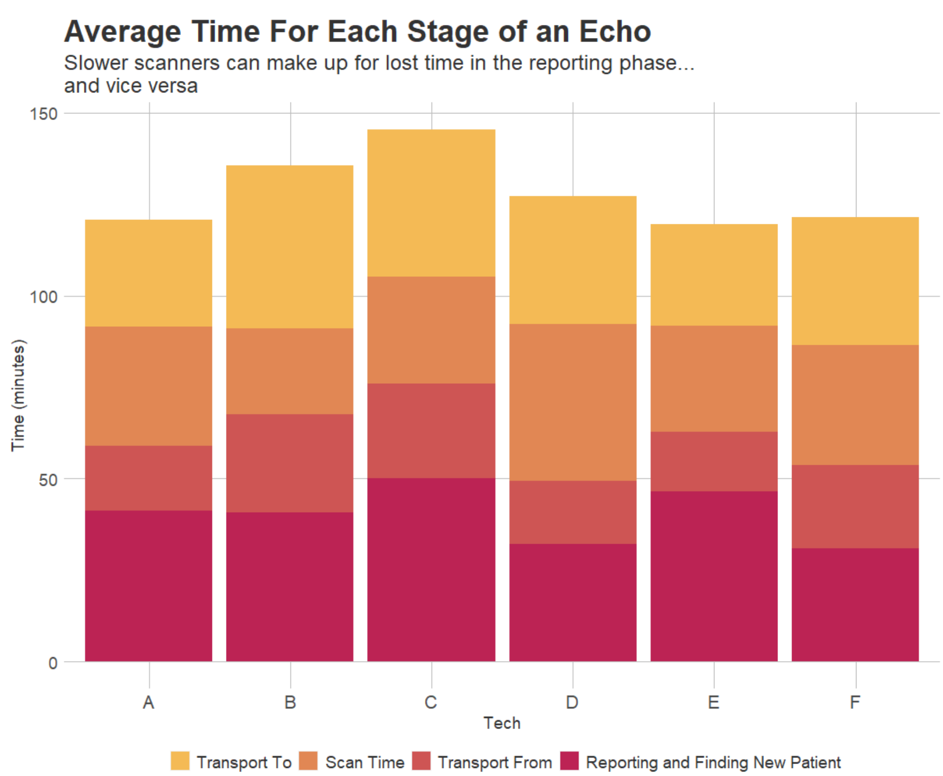

Figure 1

Note that transport to the lab is the second longest and most variable stage in the process. Echoes cannot begin until the patient is in the room, so this stage can have a crucial impact on the flow of the day. However, transport to the lab is not the only factor affecting throughput. Within the sample, sonographers met their minimum required quota of echoes only 50% of worked days, while transport was slower than average for only 33% of worked days. There was no statistically discernable relationship between average daily transport time and whether a sonographer met the minimum expectation.

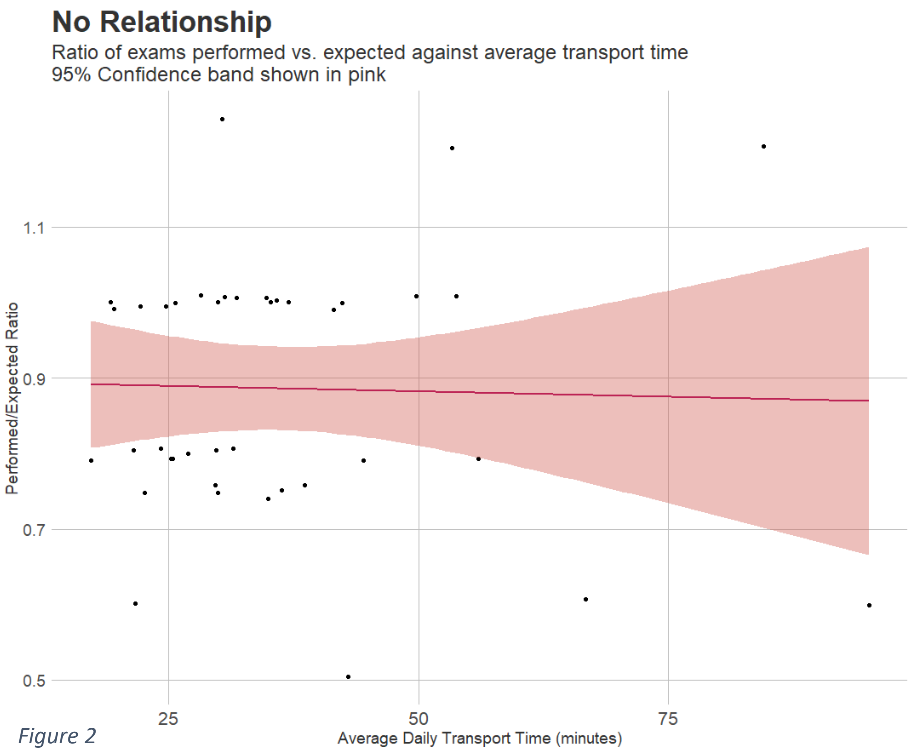

Figure 2

Average daily transport time is not significantly related to the number of exams a sonographer is able to perform in a day (p = 0.86, R^2 = 0).

	Fast Transport	Slow Transport
Met Quota	**13**	**7**
Unmet Quota	**14**	**6**

Table 2: Pearson's chi-squared = 0, df = 1, p-value = 1

If faster transport times will not make much of a difference, what can be done to increase the likelihood of reaching the minimum number of exams?

One possibility is going portable more often, and crucially, taking more than one exam at a time when doing so. When doing back-to-back exams in the echo lab, Time Between (time difference between the last picture of the first exam and the first picture of the second exam) is an average of 71 minutes. Taking one exam portable leaves an average Time Between of 59 minutes. Taking two or more exams portable leaves an average Time Between of only 44 minutes (p = 0.007).

Exam type is also a significant factor, but this should not be inappropriately adjusted (for multiple reasons, ethical and otherwise). Similarly, scanning time is a significant factor but is highly sonographer dependent, and encouraging short scan times may create perverse incentives. Definity use should not be discouraged either, as it does not significantly increase the scanning time of a complete echo.

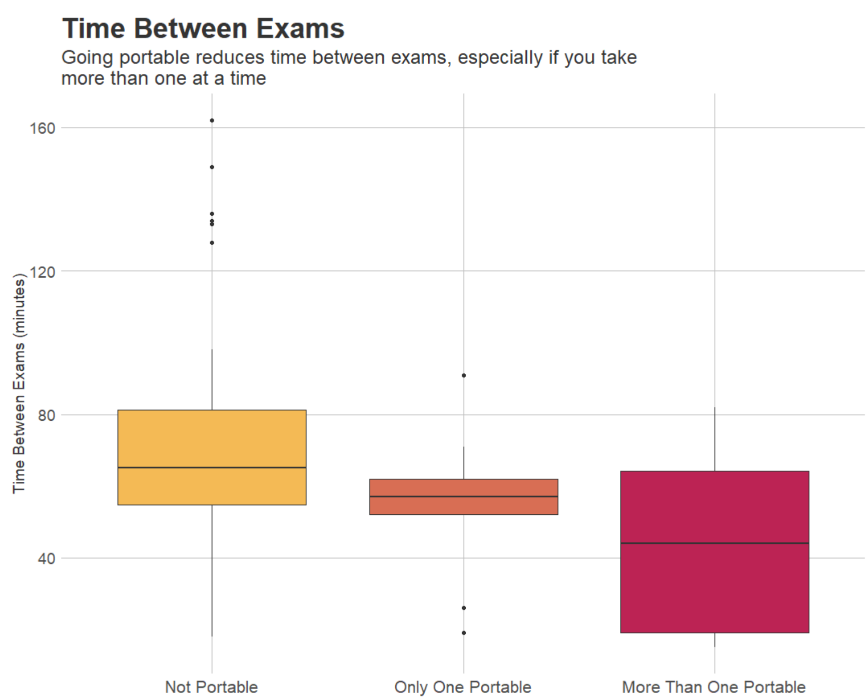

Figure 3: Kruskal-Wallis chi-squared = 9.9638, df = 2, p-value = 0.006861

One way to reduce time between exams is to move patients out of the echo labs faster. There is a significant amount of time (an average of 21.9 minutes) between the last image taken on an exam and the beginning of the reporting period. Oftentimes this is due to a delay in the transportation department's ability to pick up the patient from the exam room. This can be partially alleviated by the sonographer performing their own transport. This is only recommended in the case of extreme delays, otherwise the time savings are minimal and can even be negative when applied inappropriately.

More creativity may be needed if the goals of the lab are to finish echoes in a timely manner. It may require advance coordination with nursing staff, as scheduling exams not only reduces the amount of time needed to search for a new patient, but also reduces transport times as nurses can anticipate the needs of the lab. When transport is unavailable or significantly delayed, use of various holding areas should be explored. Within a short walk of the echo lab there are cath lab, interventional radiology, and diagnostic imaging holding areas. It may be possible to coordinate with nurses there to temporarily watch echo lab patients if transport is busy. This would allow the sonographers to begin another exam immediately. Finally, sonographers should send for their next patient before reporting on the prior. This would allow an overlap of tasks and save an estimated average of 20 minutes per exam.

Much emphasis is (and should be) placed on the subjective quality of echocardiograms in this lab, the primary argument being that the highest quality exam provides the best patient care. It is crucial to remember that reducing wait times for echoes is also patient care, and we should strive to achieve high quality in this arena just as much. There is no trade off here. Improving workflow does not mean reducing exam quality, it only means providing excellent service to more patients.

Methodology

This is a retrospective observational study. Information on a sample of 148 echocardiograms from 13 days was collected on two periods, one dating from 2/3/2023 to 2/7/2023, and another from 5/3/2023 to 5/10/2023. These periods were chosen to reflect the "typical" lab conditions, namely periods when only and all full-time sonographers were present (i.e., the data are not collected on agency staff/travelers or per diem sonographers). Since this analysis is focused on time allocation, exams requiring more than one sonographer ("2fers") were recorded as two separate entries to better track individual sonographer workflow. See Table 4 of the Appendix for the distribution of exam types and sonographers. Since the data were recorded retroactively, some information is unavailable, namely the reporting time. As a result, "reporting time" and "time to find a new patient" have been combined. The time stamps for most steps in the process are available either in Epic or Change Healthcare (McKesson) CPACS and were recorded manually.

For Table 2, Fast Transport times were considered to be the daily average transport time below the overall mean of 36.5 minutes. Slow Transport times were times greater than or equal to the mean. A sonographer was considered to have met quota if their Performed vs. Expected Ratio was 1 or more, else the quota was unmet.

Kruskal-Wallis rank sum tests were performed for multi-group comparisons, with Dunn's test and Holm's step-up family wide error-rate adjustment for all post-hoc comparisons of significant effects. All tests are two-sided with alpha = 0.05. All analysis was performed in R version 4.2.3.

Appendix

	Mean $\pm$ SD (minutes)
"Exam Begun" to First Picture	**36.5 $\pm$ 28.1**
Last Picture to "Exam Ended"	**21.9 $\pm$ 16.2**
Scan Time	**31.1 $\pm$ 15.1**
Total ("Begun" to "Ended")	**89.5 $\pm$ 30.5**
Time Between Exams	**66.8 $\pm$ 28.4**
Reporting and Finding Next	**40.2 $\pm$ 26.3**

Table 3

Exam Type	Sonographer	A	B	C	D	E	F	Total
BAV		**0**	**1**	**0**	**0**	**1**	**0**	**2**
Limited		**1**	**0**	**0**	**0**	**1**	**2**	**4**
Limited w/ Definity		**1**	**4**	**1**	**2**	**4**	**2**	**14**
TEE		**1**	**4**	**7**	**0**	**1**	**0**	**13**
Complete		**0**	**4**	**4**	**0**	**2**	**5**	**15**
Complete w/ Definity		**21**	**24**	**22**	**23**	**10**	**17**	**117**
Total		**24**	**37**	**34**	**25**	**19**	**26**	**165**

Table 4

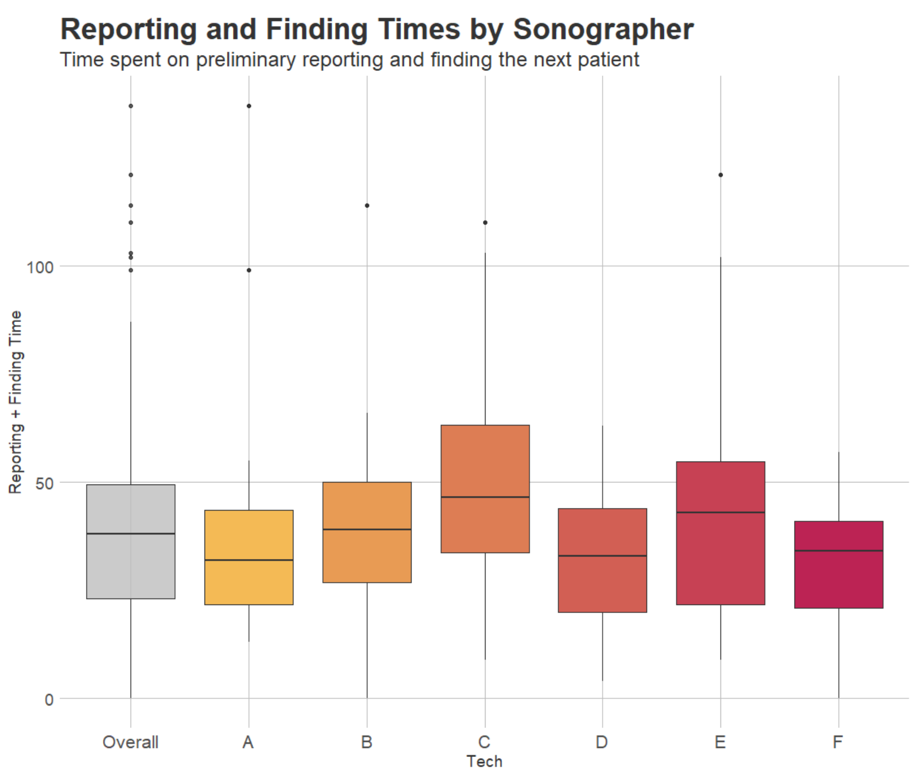

Figure 4: Kruskal-Wallis chi-squared = 9.0984, df = 5, p-value = 0.1052

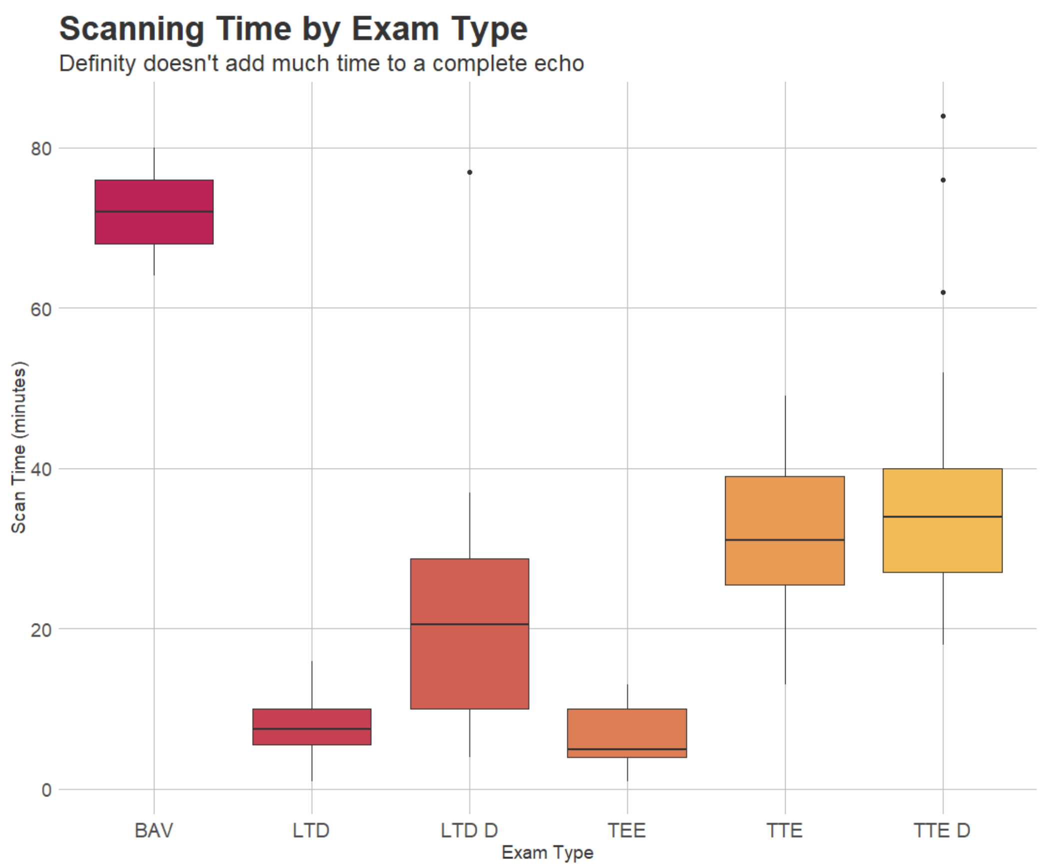

Figure 5: Kruskal-Wallis chi-squared = 59.502, df = 5, p-value = 1.54e-11

Col Mean – Row Mean	BAV	LTD	LTD D	TEE	TTE
LTD	**z = 3.608937 p = 0.0018**				
LTD D	**z = 3.141234 p = 0.0076**	**z = -1.324430 p = 0.2780**			
TEE	**z = 4.168371 p = 0.0002**	**z = 0.071136 p = 0.4716**	**z = 2.055109 p = 0.0997**		
TTE	**z = 2.098433 p = 0.1076**	**z = -2.746938 p = 0.0241**	**z = -2.139080 p = 0.1135**	**z = -4.186663 p = 0.0002**	
TTE D	**z = 1.945996 p = 0.1033**	**z = -3.417459 p = 0.0032**	**z = -3.489439 p = 0.0027**	**z = -6.082951 p = 0.0000**	**z = -0.699740 p = 0.4841**

Table 5: Dunn's Test of Multiple Comparisons for scanning time by exam type

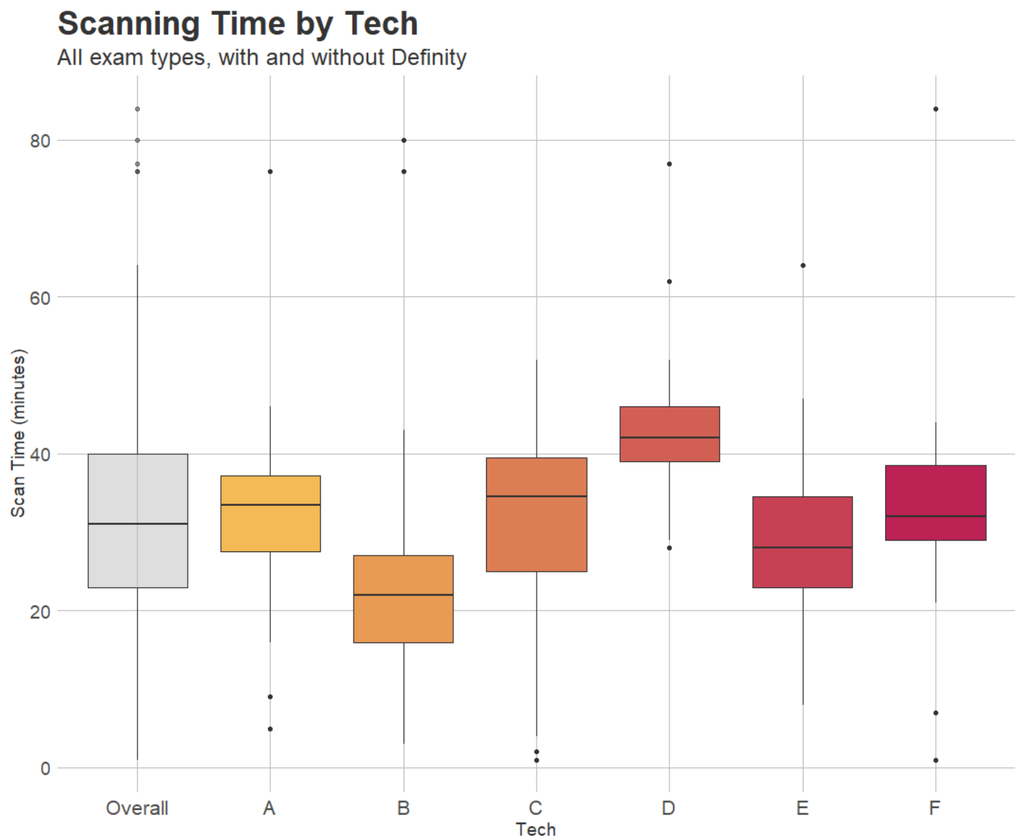

Figure 6: Kruskal-Wallis chi-squared = 43.191, df = 5, p-value = 3.38e-08

Col Mean – Row Mean	A	B	C	D	E
B	**z = 3.166148 p = 0.0085**				
C	**z = 0.316688 p = 0.7515**	**z = -3.137621 p = 0.0085**			
D	**z = -2.949559 p = 0.0127**	**z = 0.071136 p = 0.0000**	**z = -3.519827 p = 0.0028**		
E	**z = 0.965328 p = 0.8360**	**z = -1.889882 p = 0.2057**	**z = 0.740149 p = 0.9184**	**z = 3.743465 p = 0.0013**	
F	**z = -0.018731 p = 0.4925**	**z = -3.263420 p = 0.0066**	**z = -0.344432 p = 1.0000**	**z = 2.990271 p = 0.0125**	**z = -0.999732 p = 0.9523**